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ENGINEERING AND EQUIPMENT

No. 86

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NUCLEAR ENERGY

UDC 621.039.51

EFFECT OF UO₂ REFLECTOR ON KINETICS OF PROMPT NEUTRONS IN FAST REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 4 May 81) pp 69-71

AVRAMOV, A. M., ZHURAVLEV, V. I., MAKAROV, O. I., MATVEYENKO, I. P.
and PROKHOROV, A. V.

[Abstract] A study was made to determine the effect of a UO₂ reflector on the kinetics of prompt neutrons in fast reactors. The time spectrum of neutron flux density decay in a UO₂ prism was measured and recorded in four strategically located vertical channels with pulse-ionization fission chambers containing layers of U²³⁵ and natural uranium. The energy spectrum of the neutron absorption rate in a UO₂ reflector was calculated according to the ARAMAKO program. Subsequent calculations according to the DNESTR program for conditions corresponding to BFS-28 and BFS-24 large physical models of infrasubcritical reactor assemblies confirm the existence of two plateaus in the energy spectrum of the logarithmic decrement. The lifetime of these plateaus is, however, shortened by the UO₂ neutron reflector forming when the decrement exceeds the minimum rate of interaction of neutrons and the ambient medium. Such a UO₂ reflector thus stores low-energy neutrons and boosts the system during transients. Figures 3, references 7: 6 Russian, 1 Western.

[170-2415]

UDC 621.311.25:625.039

PRESTART-UP CHEMICAL TREATMENT OF INTERNAL SURFACES IN AES

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 17 Nov 80) pp 62-64

SEDOV, V. M., KRUTIKOV, P. G. and ZOLOTUKHIN, S. T.

[Abstract] A chemical technique is proposed for prestart-up treatment of internal metal surfaces in AES's with water-moderated water-cooled reactors

or with water-graphite channel reactors. It is based on data on corrosion of 20 carbon steel, Kh18N10T chromium-nickel steel, and MNZh copper alloy. The treatment consists of four steps in the following sequence: washing away mechanical contaminants with water, washing away chemical contaminants with a solution (acid + complexes to pH = 3), another rinse with water, passivation (with $N_2H_4 \cdot H_2O$ or $NH_4 \cdot OH$ to pH = 10.4). Figures 2, tables 3, references 9: Russian.
[170-2415]

UDC 621.039.562

INVERSE PERIOD OF ULTRASUPERCritical REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 28 Nov 80) pp 44-46

SHISHIN, B. P.

[Abstract] The inverse period of an ultrasupercritical reactor is an important parameter on which the probability of fault occurrence depends. One method of determining this parameter is based on equations that describe the space-energy and angular distribution of neutron flux density for a given reactor with exponentially varying power and for a corresponding second reactor with identical geometry and fuel but made of a different material. Integration of these two equations with respect to all variables in the phase space and subsequent subtraction of one from the other yields a relation between the inverse periods of the two reactors. The criterion functional that characterizes the difference between operators D_1 and D_2 in the respective two equations can be evaluated either by special numerical analysis for each case, or much simpler with the aid of differential experiments. The resultant equation for the two inverse periods is differentiated with respect to a characteristic geometric reactor dimension. This method is based on the premise that a small change in the characteristic dimension will cause the inverse periods of the two reactors to change differently. For simplicity, no temperature feedback is assumed to exist in the two reactors and the absorber is assumed to have a negligible effect on neutron scattering and retardation. The neutron decay constants are measured in two groups of experiments. In the first group of experiments the geometric dimension of an unpoisoned reactor is varied from $x = a$ (minimum for a critical reactor) to $x = b$ (maximum for a supercritical reactor). In the second group of experiments the reactor remains constantly at the maximum poisoning level as the geometric dimension is varied from $x = a$ (reactor subcritical) to $x = b$ (reactor critical). Figure 1, references 3:

2 Russian, 1 Western.

[170-2415]

UDC 621.039.58

RADIOACTIVE CORROSION PRODUCTS IN LOOP OF FAST REACTOR WITH DISSOCIATING COOLANT

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 22 Jan 81) pp 34-36

DOLGOV, V. M. and KATANAYEV, A. O.

[Abstract] A spectrometric study of radioactive corrosion products in the inner loop of a fast reactor with dissociating N_2O_4 coolant was made according to standard procedures with use of a semiconductor-type detector. The elemental composition of the nonradioactive part of shifting deposits was determined through activation analysis. The data on distribution of Co^{58} , Co^{60} , Mn^{54} isotopes between fixed and shifting deposits on surfaces in the core-to-evaporator zone with gas at 573 K, in the condenser containing gas at 393 K and liquid at 373 K, and in the evaporator-to-core zone with a gas scrubbing filter at 663 K and a vertical gas duct at 493 K reveal an exponential-law decrease of the relative numbers of radio-nuclides in fixed deposits as the coolant temperature drops and gas-to-liquid phase transition occurs. The elemental composition of deposits was found to differ both qualitatively and quantitatively from that of the matrix. The results agree with the hypothesis that chemical compounds with stable Co and Mn are more volatile, while compounds of Ni and Cr are more prone to dissolution in N_2O_4 liquid or vapor. Placing the filters directly behind the zones of coolant phase transition will, according to this study, abate the radiation hazard. Figure 1, tables 2, references 3 Russian.

[170-2415]

UDC 621.039.526

DEPENDENCE OF THERMODYNAMIC EFFICIENCY OF AES ON THERMAL EFFECTS OF CHEMICAL REACTION IN DISSOCIATING COOLANT

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 1 Dec 80) pp 28-34

NESTERENKO, V. B.

[Abstract] A relation is established between the thermal effect of reversible chemical reactions involving gaseous N_2O_4 during heating or cooling over the 300-800 K temperature range under pressures of 0.1-15 MPa, namely $N_2O_4 \rightleftharpoons 2NO_2 + 6234 \text{ kJ/kg}$ and $2NO + O_2 \rightleftharpoons 2NO_2 + 1225 \text{ kJ/kg}$, and the operating conditions in an atomic electric power plant with a gas(dissociating)-cooled fast breeder reactor. The net thermal effect of these dissociation and recombination reactions in the reactor, in the high-pressure turbine cylinder, in the low-pressure turbine cylinder, and in the regenerator is evaluated on the basis of the particular operating temperature and pressure ranges as well

as coolant requirements in each. Thermophysical characteristics of this coolant and performance characteristics of such reactors as well as technological factors, based on data available at the Institute of Nuclear Research from numerous model and field studies, are taken into account in the evaluation. The author thanks Academician A. P. Aleksandrov for recommending that this study be undertaken. Figure 1, tables 3, references 12: 10 Russian, 2 Western.

[170-2415]

UDC 539.3

STATE OF STRESS OF LARGE-DIAMETER PIPES IN RBMK WATER-GRAPHITE CHANNEL REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 1 Oct 80) pp 17-21

DMITRIYEV, V. S., LIFANT'YEV, A. N., PRONINA, V. N. and FILATOV, V. M.

[Abstract] Pressure and suction pipes for the forced-circulation system in atomic electric power plants with water-graphite channel reactors are up to 752 mm in diameter and made of 22K steel with corrosion-resistant 08Kh18N10T plating on the inside. The state of stress of such pipes was measured with strain gauges in tests simulating most typical steady-state and transient conditions: heating to 295°C under 7.4 MPa gauge pressure at a rate of 10°C/h, operation at nominal reactor power level, cooling to 30-40°C with reduced gauge pressure at a rate of 10°C/h, duty cycling, and fault clearing. Static stresses (membrane, flexural, torsional) as well as thermal stresses were measured. The allowable stresses were then determined from these data and model calculations with strength analysis, assuming a unity strength factor for welded joints. Referred to the allowable membrane stress σ_M , the principal limiting component and equal to either the yield strength or the ultimate strength (whichever is lower) of the base metal, the pipes fall into three classes with allowable total stress at 295°C equal to 1) σ_M , 2) $1.3\sigma_M$, 3) $2.5\sigma_M$ respectively. The maximum stress during testing in the steady-state mode was 7.5 kgf/mm² in a suction pipe and 6.8 kgf/mm² in a pressure pipe, well below the maximum allowable. The fatigue stress factor, based on 300 duty cycles and 1000 fault cycles, was found to be 0.69. Figures 3, references 5 Russian.

[170-2415]

UDC 543.544:621.039.5

OPERATIONAL AUTOMATIC INSPECTION OF RADIOACTIVITY FROM FISSION PRODUCTS IN
WATER COOLANT IN NUCLEAR REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 3 Jun 81) pp 14-17

MOSKVIN, L. N., LEONT'YEV, G. G., MIROSHNIKOV, V. S. and
NEKREST'YANOV, S. N.

[Abstract] A radioactivity analyzer has been built on the principle of quasi-continuous two-dimensional chromatography for use in atomic electric power plants, where the activity level of individual radionuclides in the water coolant fluctuates over a wide range so that direct gamma-spectroscopy becomes inadequate. The instrument includes, in addition to a LANGUR gamma-spectrometer with detector and multichannel analyzer, also a pump-dosimeter with a separator and an electric drive, a choke valve, a set of electromagnetic valves, a set of test chambers, and a drain collector. This INVARIANT-02 instrument is combined with a magnetic recorder and operates automatically, with the aid of a computer, printing out numerical data. It requires 8 min for stabilization, responds in 5 min to a change in the radioactivity level in a sample, it can operate continuously for 3 h before solutions are flooded, and carries a 180 h supply of sorbents. The 12-channel dosimeter operates in the peristaltic mode. The equipment has been tested under real conditions on typical samples of water coolant containing iodine-technetium, barium-strontium, cesium-rubidium fractions and in them various radionuclides with a different half-life each. The accuracy and the information content are satisfactory for inspection purposes. Figures 3, tables 2, references 6: 4 Russian, 2 Western, [170-2415]

UDC 621.311.2:621.039

EFFICIENCY OF OPERATING WITH NEUTRAL-OXYGEN WATER CHEMISTRY IN AES WITH
BOILING-WATER REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 20 Mar 81) pp 10-13

ANAN'YEV, Ye. P., ANDREYEVA, A. B., DUBROVSKIY, I. S., YESHCHERKIN, V. M.,
ZABELIN, A. I., KRUZHILIN, G. N., KULIKOV, Ye. V., SOKOLOV, I. N.,
TSYKANOV, V. A., CHECHETKIN, Yu. V. and SHMELEV, V. Ye.

[Abstract] Fifty power units ranging from 250 to 800 MW in eighteen thermal electric power plants operate with neutral-oxygen water chemistry since this mode was introduced in 1974. Addition of oxygen in concentration of the order of 0.2 mg/kg to thoroughly desalinated water has been found to result in formation of stable oxide films on surfaces of carbon steel which

protect the latter almost completely against corrosion. The feasibility of applying this principle to atomic electric power plants with boiling-water reactors has been studied for two years on a 220 MW VK-50 reactor. Up to 360 t/h of steam is generated here under a pressure of 7 MPa, throttled down to 2.9 MPa behind the high-pressure separator, and passed through the low-pressure separator to the saturated-steam turbine. Equipment and piping here is made 32.8% of pearlitic steels (St 3kp, St 20, St 22k), 14% of austenitic and chromium steels, 53.2% of copper alloys (L-68 brass, MNZh-5-1) and zirconium alloys (110, 125). Corrosion measurements based on the radioactivity of corrosion products (Fe⁵⁹, Mn⁵⁶, Co⁶⁰, Zn⁶⁵ nuclides) indicate that correction of the water chemistry by addition of at least 200 $\mu\text{g}/\text{kg}$ of oxygen lowers the electrical conductivity of the coolant to $0.2 \mu\text{S}\cdot\text{cm}^{-1}$ and very efficiently reduces the amount of corrosion products entering the coolant from the steel surfaces. Figure 1, tables 3, references 11: 10 Russian, 1 Western.

[170-2415]

UDC 621.039.514

THEORETICAL STUDIES OF TRANSIENT AND FAULT MODES IN FAST REACTORS AND THEIR ROLE IN SAFETY ASSURANCE

Moscow ATOMNAYA ENERGIYA in Russian Vol 52, No 1, Jan 82
(manuscript received 10 Mar 81) pp 3-10

BAGDASAROV, Yu. Ye. and KUZNETSOV, I. A.

[Abstract] Study of transients and faults in components of nuclear power plants with fast reactors is reviewed, such studies serving as the premise on which protective measures are devised. Theoretical analysis involves essentially calculation of the temperature field in the reactor core and heat transfer in heat exchangers as well as in piping and in mixing chambers. These calculations require solution of generally first-order ordinary or partial differential equations of heat conduction, with subsequent refinement on the basis of experimental data and with hydromechanical transient processes in the liquid-metal coolant also taken into account. Various mathematical models and computer programs are available for these calculations. The next step is applying the results to the design of protective equipment. It is necessary to estimate the permissible faulty deviations of reactor performance parameters and the effectiveness of any particular design. Thermal shock, which affects both design and performance of fast and slow protection systems must be considered as well as residual energy release with the required aftercooling. Finally, service constraints on normal transients must be established. Then the self-regulation and the stability of a reactor can be determined. Experience has shown that the fast reactors BN-350, BN-600, Phénix and PFR have excellent self-regulation and stability characteristics. References 46: 40 Russian, 6 Western.

[170-2415]

UDC (621.311.25:621.039):621.182.182.448-57.004.13

CHEMICAL AND TECHNOLOGICAL CONDITIONS DURING STARTING AND INITIAL OPERATING PERIODS IN AES WITH WATER-GRAPHITE CHANNEL REACTOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 12, Dec 81 pp 9-10

VOLGIN, G. D., candidate of chemical sciences, Leningradskaya AES

[Abstract] In response to the article "Chemical and Technological Conditions during Starting and Initial Operating Periods in AES with RBMK Water-Graphite Channel Reactor" by V. M. Sedov, P. G. Krutikov and S. T. Zolotukhin (ELEKTRICHESKIYE STANTSII No 2, Feb 81), this author insists that chemical and technological conditions during start-up are not identical to those during post-overhaul and prestart periods. A case in point is the treatment of the inside surfaces in the condensate-feed loop at the Leningrad AES, where a rinsing process with water containing no reagents has been developed on the basis of experience with hydrogen peroxide at the Krupskiy AES. Considering the importance of maintaining the correct water chemistry during subsequent operating periods, the author agrees that chemical rinsing with ammonium monocitrate and passivation with sodium nitrate or ammonia, methods used in heat power equipment, are not appropriate for atomic electric power plants with water-graphite reactors.

[180-2415]

UDC (621.311.25:621.039):621.039.633.004.14.002.237

IMPROVEMENT OF FUEL UTILIZATION IN AES'S WITH WATER-MODERATED WATER-COOLED VVER-440 POWER REACTORS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 12, Dec 81 pp 8-9

MATVEYEV, A. A., engineer, SAVCHUK, Yu. I., engineer, and IGNATENKO, Ye. I., engineer, Kol'skaya AES

[Abstract] Studies were made to determine how the degree of fuel burnout in a water-moderated water-cooled nuclear reactor of an AES depends on the fuel enrichment. It has been established, as a result, that adding enriched makeup fuel and simultaneously reducing the number of recharged fuel assemblies will lengthen the steady-state fuel cycle. Thus, with 3.6-4.4% U fuel and 78 instead of 102 fuel assemblies recharged, it is possible to lengthen the operating period of a VVER-440 reactor to four years and an individual fuel cycle to one year. This will reduce the fuel cost by 7.9% and the total cost of energy production by 3.1%. Figures 2, table 1, references 3 Russian.

[180-2415]

NON-NUCLEAR ENERGY

UDC 628.165

ANALYSIS OF DETERGENT WATER IN TETs'S OPERATING WITH HIGH-SULFUR FUEL OIL

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 4, Oct-Dec 81 pp 19-21

SIRINA, T. P., candidate of technical sciences, ALESHKINA, A. A., engineer, and INYUSHINA, L. V., engineer, Chelyabinsk Scientific Research Institute of Metallurgy; KRASNOSELOV, G. K., engineer, Bashkir Regional State Administration of Power System Management; TOMASH, Z. P., engineer, Kiev Heat and Electric Power Plant No 5

[Abstract] Sludge produced during neutralization of detergent water and that enters the waste from boilers in TETs's operating with high-sulfur fuel oil serves as a substantial and regular source of vanadium. For the purpose of evaluating the vanadium content in the waste after hot and cold boiler surfaces have been washed, analyses were performed on samples from the Kiev TETs No 5 and the Ufa TETs No 4. The concentration of V_2O_5 in the various solid and liquid fractions was found to depend on the pH, the latter varying from 0.15 to 3.85, and up to 20% of the vanadium deposited by the fuel oil is extractable by washing of type TGM-84 boilers. The average overall V_2O_5 content in pulp reaches 4.18 g/l. Its extraction should thus make up to 2,000 t/yr more of V_2O_5 available for covering the needs of the national economy. Tables 3, references 3 Russian.

[169-2415]

UDC 681.5:621.311:621.18

REFINEMENT AND DEBUGGING OF POWER REGULATION SYSTEM FOR 800 MW UNIT WITH TGMP-204 BOILER

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 4, Oct-Dec 81 pp 12-15

ALTYN, S. V., engineer, DAVYDOV, N. Ye., engineer, and TITKOV, Ye. P., engineer, Donets Regional State Engineering Administration of Power System Management

[Abstract] The power regulation system for 800 MW units in the Uglegorsk GRES consists of a boiler power regulator, a setting speed limiter and a

turbine regulator. Several deficiencies were found in this system, namely redundant actuation of the boiler power regulator during movement of turbine valves, despite adjustments of the decoupling differentiator, nonoptimum operation of the turbine regulator on the basis of power settings, and inadequate performance of the automatic protective interlocking system. Subsequent refinements were made by using for debugging a nonlinear analog model of the dynamic power and pressure characteristics based on simulation of the transient response to turbine perturbations at the valves at 95% and 55% power levels. Reliability of the protective interlocking is improved by automatic reclosing after the fault, which ensures a stable transient process and necessary boiler load limitation. Use of nonlinear analog model facilitates regulator adjustment with fewer load change tests. Figures 2.
[169-2415]

UDC 662.997:537.22(088.8)

SIMULATION AND OPTIMIZATION OF SOLAR HEATING SYSTEMS

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 8 Dec 80) pp 41-47

KOZLOV, V. B. and EYSMONT, O. A., State Scientific Research Institute of Power Engineering imeni G. M. Krzhizhanovskiy

[Abstract] A solar heating system is considered that consists of a solar water heater, a heat storage tank, a set of two heat exchangers, a set of conventional furnaces for residential hot water and central heating, two pumps, a valve, ducts and pipes, and regulators. The performance of this system is simulated mathematically with the equation of heat transfer for the heat storage tank, two equations of nonisothermal fluid flow, one for the hot-water system and one for the central-heating system, the law of energy conservation, a standard expression for the intensity of incident solar radiation (taking into account collector geometry, geographic location in terms of latitude, and position of the sun as a function of time), also a standard expression for diurnal temperature variations. All these relations are reduced to a dimensionless form, which yields dimensionless parameters subsequently used for optimizing the system with respect to minimum normalized costs. Calculations for a typical location at the southern Crimea shore indicate that solar heating with panels costing 50 rubles/m² becomes competitive when the cost of conventionally produced heat reaches and exceeds 19 rubles/Gcal. Figures 4, references 6:
4 Russian, 3 Western.
[175-2415]

UDC 621.47

CALCULATION OF PAYOFF PERIOD FOR SOLAR WATER HEATERS

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 29 Oct 80) pp 35-36

USMANOV, M. U., Physico-Technical Institute imeni S. V. Starodubtsev,
UzSSR Academy of Sciences

[Abstract] The payoff period for solar water heaters is calculated on the basis of a few modifications of the general formula applicable to any new technology $T = (K_{\text{new}} - K_{\text{old}})/(C_{\text{old}} - C_{\text{new}})$ (K - capital investment costs, C - production costs), in this case solar energy (new) versus fuel energy (old). As a further refinement, the error in estimating the capital investment costs is accounted for in terms of the equivalent fuel cost, considering that a solar heating plant does not replace but supplements a fuel-type heating plant. Since the error can be both ways, maximum and minimum payoff periods can be established on this basis. With available cost and performance data for a typical location in the Tashkent region, the nominal payoff period for a solar heater installed here can be calculated as $T = 13.25 \frac{e}{b}$ (e - efficiency of fuel-type heater, b - seasonal utilization factor of solar heater). This yields typically 7-14 years.

References 6 Russian.

[175-2415]

UDC 662.996:537.22

EXPERIMENTAL STUDY OF THERMAL PROCESSES IN TRANSLUCENT-BUFFER HOTHOUSE INSULATION

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 10 Feb 81) pp 32-34

VARDIASHVILI, A. B., TEMURKHANOV, A. and KIM, V. D., Karshi State Pedagogical Institute

[Abstract] Solar hothouses were tested with two types of translucent buffer insulation: 1) polyethylene film spread underneath the triangular glass roof parallel to the panes on both slopes at a distance of 0.06 m from them so as to provide a 0.06 m thick plane-parallel air interlayer; 2) polyethylene film spread underneath the triangular glass roof horizontally across it so as to provide a triangular (in elevation view) translucent buffer insulation. Ascending and descending air currents in such insulations have an appreciable effect on the thermal processes, they enhance heat transfer by natural convection and inhibit heat transfer by conduction without affecting heat transfer by radiation. Measurements were made on 23 February 1981 with thermometers and copper-constantan thermocouples.

Convection currents were traced with tobacco smoke and aluminum powder. Calculations based on the experimental data, using an equivalent convection coefficient referred to the thermal conductivity of air and a conventional relation for the thermal flux density, indicate that the temperature drop across a horizontal polyethylene film is 4-5°C in cloudy weather and 2-3°C in sunny weather. The heat loss in buffer insulation is 27-29% lower than in a 0.06 m thick interlayer. Figures 3, table 1, references 3 Russian. [175-2415]

UDC 662.997

TEST RESULTS ON SDU-E SOLAR DISTILLERS WITH ENAMEL-COATED THERMORECIEVERS

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 24 Jun 81) pp 28-31

KAMILOV, O. S., UMAROV, G. Ya., ACHILOV, B. M., ALIMOV, A. K. and GUNER, Ye. A., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] The SDU-E solar distiller has been designed to supply fresh water to sheep and lamb raising farms in inaccessible underpopulated areas or in salty southern regions. The equipment consists of a tank for raw water on a high pedestal, a downward sloping distiller, a drain for raw water, a conduit for distillate, and a tank for distillate on a low pedestal. The distiller is a long pan of rectangular cross section divided into a series of cells by baffles, one behind the other, rigidly joined to the bottom and both lateral walls. It is made of 0.8 mm thick cold-rolled St-3 sheet steel, coated with two layers of black enamel to improve both the radiation absorption and the corrosion resistance. Bottom and lateral walls are insulated from the ambient air by a layer of PPU-307 polyurethane foam. Such a distiller consisting of four consecutive cells with a surface area of 0.52 m² each was tested in August-September-October 1978 and May 1979, with all climatic conditions accounted for (solar radiation, air temperature, wind velocity). The results indicate this distiller produces drinking water that meets all sanitary standards. The low thermal inertia (weight of 13.8 kg per cell) and the precise hermetization make its efficiency 25-40% higher than that of other known solar distillers. Figures 3, tables 2, references 2 Russian.

[175-2415]

UDC 662.997:537.22(088.8)

THERMOTECHNICAL CHARACTERISTICS OF SOLAR ENERGY COLLECTOR WITH SELECTIVE COATING AND VACUUM INSULATION

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 14 Jul 81) pp 25-27

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Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] A study was made to determine the thermotechnical characteristics of a solar energy collector consisting of an array of thermoreceivers in the form of parallel glass tubes with a selective coating and vacuum insulation, in a structure designed to facilitate natural circulation of the heat carrier. The experimental model was built in the form of a large tube (50 mm in diameter) with transversely running heat-exchanger copper tubes of a smaller diameter (25 mm in diameter, 45 cm long, 1.5 mm wall thickness) inside and thermoreceiver tubes (29-30 mm in diameter, 20-21 cm long) slipped coaxially on the latter. The gap between heat-exchanger tube and thermoreceiver tube was filled with a heat conducting paste. Glycerin was used as heat carrier naturally circulating inside the container tube, flowing through the heat-exchanger tubes and the paste. Each thermoreceiver tube was surrounded by a layer of vacuum under a translucent shield (emissivity 0.9, transmission coefficient 0.87) nesting in aluminum foil. The collector was tested in Samarkand (UzSSR) during the 19-25 August 1979 period. At an ambient temperature of 40°C, the maximum collector outlet temperature was 131°C (absorption coefficient of thermoreceivers 0.9, emissivity of selective coating 0.1, maximum temperature differential at heat-exchanger ends 10°) and the useful power output was 320 W/m². The average efficiency for the 10 AM to 5 PM period of the day was 28-30%. Figures 2, table 1, references 7 Russian.

[175-2415]

UDC 662.997:662.93(73)

OPTIMIZING REQUIRED SURFACE AREA AND SOLAR HEATER INCLINATION ANGLE IN SOLAR HEATING SYSTEM

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 29 Oct 80) pp 20-24

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[Abstract] Design optimization of a solar heater for maximum economy is considered, in terms of surface area and inclination angle, on the basis of

a comparative cost analysis of a combination heating plant run on solar energy and fuel and a conventional heating plant run on fuel alone. While the optimum surface area depends on the inclination angle, the maximum reduction of annual costs is found to be attainable through concurrent optimization of both parameters. The actual optimum area and angle as well as the actual saving in rubles/year will depend on the specific climate and seasonal variations, on the thermotechnical characteristics and the installation cost of each equipment, and on the fuel cost. For a typical cottage in Mkhachkala (Dagestan ASSR) a solar heater with a surface inclined at 30° to the horizontal and with an area within 15-30 m² should save up to 126 rubles/year. Figure 1, tables 3, references 7 Russian.
[175-2415]

UDC 662.997:537.22(088.8)

DESIGN OF SOLAR ENERGY CONCENTRATORS ON GROUND

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
(manuscript received 30 Jul 80) pp 16-19

TVER'YANOVICH, E. V., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] Concentrators on ground, a new type of solar energy concentrators, have the capability to concentrate scattered radiation and to operate in the steady mode. Such a concentrator is essentially a prism with the receiver face under a reflective coating at a definite angle to its front face and with an exit face for concentrated radiation. The design of this prism is based on laws of geometrical optics. First the basic configuration is selected, depending on the layout and installation requirements. Then the material with the necessary incidence angle are determined which will yield the required concentration factor in this configuration. Finally, the receiver dimensions are selected and the dimensions of the lateral surfaces are determined accordingly. The problems of transverse and longitudinal defocusing should also be considered. Figures 4, table 1, references 2:
1 Russian, 1 Western.
[175-2415]

NEW POSSIBILITIES FOR DESIGN AND OPTIMIZATION OF TANDEM SOLAR CELLS

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
 (manuscript received 24 Oct 80) pp 7-15

KAGAN, M. B. and LYUBASHEVSKAYA, T. L., "Order of Labor's Red Banner"
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[Abstract] Tandem solar cells are stacks of p-n junctions or other barriers produced by liquid-phase or gaseous-phase epitaxy in "photoelectric" semiconductor materials with different intrinsic energy gaps. Such devices offer possibilities for attainment of high efficiencies through optimization. The major design factors to be considered include the combination of materials, the number of layers, the real current-voltage characteristics of p-n junctions, especially in the case of wideband materials, deviating from that of an ideal Schottky junction, and inverse dark current produced by generation-recombination or other mechanisms. An analysis of these factors reveals that the maximum attainable efficiency near 45% is reached with five layers and addition of more layers will not increase it further. The best combinations of materials are 2-stage AlAs-GaAs (p-Ga_{1-x}Al_xAs/n-Ga_{1-x}Al_xAs/p-GaAs/n-GaAs) and GaAs-Ge (p-Ga_{1-x}Al_xAs/p-GaAs/n-GaAs/n-Ge/p-Ge) systems and 3-stage Ga_{1-x}Al_xAs/GaAs/Ge system. Although the choice of materials will be the same whether dark current is produced by the "pure" diffusion mechanism or the "hybrid" diffusion mechanism, the efficiency will be approximately 6% higher with the "hybrid" mechanism in wideband materials. The efficiency can be further controlled through the thicknesses of the basal junction layers. Figures 4, tables 2, references 16: 4 Russian, 12 Western.
 [175-2415]

SOLAR PHOTOELECTRIC 200 W POWER UNIT WITH AlGaAs HETEROPHOTOVOLTAIC CELLS AND MIRROR-TYPE CONCENTRATORS

Tashkent GELIOTEKHNIKA in Russian No 6, Nov-Dec 81
 (manuscript received 5 Aug 81) pp 3-6

ALFEROV, Zh. I., ANDREYEV, V. M., ARIPOV, Kh. K., LARIONOV, V. R. and RUMYANTSEV, V. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] A solar photoelectric 200 W power unit has been developed for use in the southern regions of the USSR wherever electric power is not otherwise available. It consists of 18 modules mounted in two frames, 3x3 per frame. Each module includes an n-GaAs/p-GaAs/p-Al_xGa_{1-x}As heterophotovoltaic cell with a 25-30 μ m thick AlGaAs layer serving as converter, a

parabolic mirror 50 cm in diameter with 50 cm focal length (developed at the Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences) serving as concentrator, and a thermosiphon evaporator made of AMts aluminum alloy for carrying the heat away by air convection. The power unit is coupled to an east-to-west sun tracking system with quick return before dawn. The power unit is completely autonomous, the tracking system is automatically controlled and driven by electric motors energized from a storage battery. The power unit was tested in Leningrad, in July 1981. Defocusing of the sun's image over the entire light-sensitive surface of the heterophotovoltaic cells yielded the flattest possible current-voltage characteristic, with the open-circuit voltage of a module reaching 1.05 V (1.15 V when water-cooled) and the total current remaining 14.6 A from approximately 0.7 V to short-circuit. A module can deliver 9-11 W power at an efficiency up to 18.5%, with reflection from protective glass and with shielding contact screen. The performance is somewhat better in a strong wind. Field tests conducted for two months indicate a large margin of power still available, if converters and concentrators can be designed to operate at their maximum capacity. The authors thank G. A. Umarov and A. K. Alimov for building the concentrators, A. S. Kostygov for delivering the thermosiphon blanks, M. B. Kagan for providing the heterostructure specimens, B. M. Yegorov and Kh. A. Rodriges for assisting in the fabrication of the heterophotovoltaic cells, and V. M. Tuchkevich for the steady interest in this project. Figures 3, references 4 Russian.
[175-2415]

UDC (621.313.17:621.314.571).001.5

DESIGN AND ANALYSIS OF PACKAGED PIEZOCERAMIC VIBRATION TRANSDUCER FOR VIBRATOR MOTOR

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 81
(manuscript received 28 Apr 80) pp 54-56

VASIL-YEV, P. Ye., candidate of technical sciences, and KARMANOV, L. L., engineer

[Abstract] A packaged piezoceramic vibration transducer consists of a smaller piezoceramic layer between two larger bars. Such transducers are used as stators of vibrator motors for ultrasonic technological processes. Here the design of such a transducer is analyzed and optimized on the basis of the appropriate wave equation, assuming that the transverse linear dimensions do not exceed one quarter of the wavelength of longitudinally propagating waves, taking into account continuity conditions at the boundaries between the piezoceramic layer and the bars (both bars made of the same high-Q material and having equal cross sections), and including the displacement-stress-voltage relation for piezoceramic materials. Calculations for various materials such as TsTS-19 and TsTBS-7 yield the thickness of the piezoceramic layer for maximum vibration amplitude at a fixed voltage amplitude under various load conditions. Calculations reveal also that it is

preferable to center the piezoceramic layer between both bars. The results agree closely with experimental data, the small discrepancy being attributable to uncertainty of the contact conditions. Figures 4, references 4 Russian. [179-2415]

UDC 621.311.22:621.186.3.001.24

DESIGN OF WARMUP PROCESS IN STEAM DUCTS DURING STARTUP OF 800 MW POWER UNIT

Moscow ELEKTRICHESKIYE STANTSII in Russian No 12, Dec 81 pp 32-35

DOVERMAN, G. I., candidate of technical sciences, MIRONOVA, V. A., engineer, and GOMBOLEVSKIY, V. I., engineer, All-Union Institute of Heat Engineering

[Abstract] Warmup of the main steam ducts leading to the high-pressure cylinder of an 800 MW power unit is necessary, because the temperature of fresh steam entering the turbine must be 100°C above the temperature of the cylinder metal (at least 300-320°C after a long shutdown). A study was made to determine how warmup from the cold state can be accelerated. Calculations were made on an M-222 computer according to the "Akkumulatsiya-2" program based on the method of finite differences. The preferable location of startup control valves as well as the preferable schedule of their opening and subsequent fuel injection have been established as a result. An analysis of the warmup process in 800 MW power units at the Surgut GRES indicates that the necessary warmup after a 144 h shutdown can be achieved in 5 min with the steam ducts connected directly to the synchronous commensator of the high-pressure cylinder. Two-line steam ducts of the 920x32 mm size, now proposed in new designs, warm up slower than four-line steam ducts of the 630x25 mm size, but the difference is less than 10 min and, therefore, not critical for purposes of analysis. Figures 5, references 2 Russian. [180-2415]

UDC 621.316.5:621.316.92:621.316.935

LINE TESTS OF ON-OFF SWITCH FOR 750 kV SHUNTING REACTOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 12, Dec 81 pp 53-55

RASHKES, V. S., candidate of technical sciences, All-Union Scientific Research Institute of Electrical Power Engineering, and OMAROV, A. N., candidate of technical sciences, All-Union Institute of Electrical Engineering

[Abstract] The on-off switch VO-750 for 750 kV shunting reactors has been designed with series VNV modules, to standardize with 750 kV circuit breakers. The module of each phase is split into two separately controllable

half-poles in series, with an external spark gap across one. Prototypes of this switch were tested on line for correct connection and disconnection of shunting reactors, for absence of breakdown during circuit breaking and subsequent readiness to close circuit through the spark gap, for adequate circuit closing through spark gap under normal switching overvoltages, for correct operation of automatic controls, and for possibility of overvoltage limiting during disconnection of reactor. The results indicate that this switch is fully operational and will improve the voltage characteristics of the protective system as well as the economy of the power system. The diode-type discharger accompanying a 750 kV reactor will probably operate during almost every circuit breaking, or closing through the spark gap, without any damage to itself. Until certain problems of capability have been resolved, the switch should not be used for more than 100 disconnect operations annually. Figures 4, references 8 Russian.

[180-2415]

UDC 621.314.214.33:621.311.22.002.51

EXPERIENCE IN USE OF VOLTAGE UNDER-LOAD REGULATORS WITH OPERATING TRANSFORMERS FOR PLANT AUXILIARIES IN LARGE POWER UNITS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 82 pp 39-42

GOSTEV, A. P., engineer, KUZNETSOV, V. P., engineer, and SAVEL'YEV, S. G., engineer, Donetsk Regional Engineering Administration of Power System Management

[Abstract] Operation of transformers for plant auxiliaries with voltage under-load regulators, to maintain a 6 kV busbar voltage, is analyzed on the basis of experience in fossil fuel and atomic electric power plants (Moldavian, Kashira, Uglegorsk GRES's). They are found to be inadequate with respect to both economy and reliability. Only in special cases of daily voltage fluctuations as wide as from 5% below to 10% above nominal, where generators must be operated with underexcitation for light loads during night hours (Novocherkassk and Lukoml' GRES's) may it be expedient to use voltage under-load regulators and preferably with automatic control. Figures 5, references 4 Russian.

[181-2415]

UDC 621.311.22.002.51.078

RESULTS OF IMPLEMENTATION OF AUTOMATIC REGULATION IN 800 MW POWER UNITS
WITH SLIDING PRESSURE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 82 pp 35-39

KOYCHU, M. B., engineer, KONDRATENKO, V. G., engineer, PERLOVSKIY, P. S.,
engineer, and SIMKIN, B. Ye., engineer, Southern Regional Engineering
Administration of Power System Management

[Abstract] An automatic regulation system has been installed in the main
800 MW power unit of the Zaporozh'ye GRES, for operation in two different
modes of sliding pressure at the turbine inlet: pressure maintained con-
stant from 800 to 720 MW and then reduced proportionally with further load
reduction to 320 MW, or reduced proportionally with further load reduction
to 560 MW and then again maintained constant down to the minimum verifiable
load level of 320 MW. The system was tested for matching the dynamic
characteristics of the boiler-turbine set during starting and load changes,
its structure and adjustment were optimized to include self-adjustment
according to load level, and it was fully tested with feed pumps operating
even at the lowest load level. With the feed pumps redesigned, it will be
possible to automatically regulate the pressure with sliding all the way
down to the lowest load level, such full sliding being optimum from the
standpoint of economy, without sacrifice of reliability. Figures 4,
table 1, references 3 Russian.

[181-2415]

UDC 621.313.322-81:621.311,22.004.1

ENERGY CHARACTERISTICS OF TURBOGENERATORS IN FOSSIL FUEL ELECTRIC POWER
PLANTS OPERATING WITH SYNCHRONOUS COMPENSATOR

Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 82 pp 22-24

MARKARYAN, L. V., engineer, ARAKELYAN, E. K., candidate of technical
sciences, TSERAZOV, A. L., candidate of technical sciences, MADOYAN, A. A.,
candidate of technical sciences, STARSHINOV, V. A., candidate of technical,
and KISELEV, G. P., candidate of technical sciences, Moscow Institute of
Power Engineering; Southern All-Union Institute of Heat Engineering;
Central Administration of Power Equipment for Nonferrous Industry

[Abstract] The power output of a turbogenerator operating with synchronous
compensation of reactive power is calculated from a linear regression equa-
tion as a function of the condenser pressure, this equation being based on
both theoretical and experimental data for TGV-200, TV2-100-2 and TVF-100
turbogenerators in thermal electric power plants operating at zero reactive
power in the steamless mode (steam fed to turbine seals and used for ejector
operation only). The power loss and the fuel consumption are also calculated,

as functions of the condenser pressure and of the steam rates in the high-pressure (or medium-pressure) cylinder and in the low-pressure cylinder. The results indicate the feasibility of simultaneously improving the maneuverability of active power and regulating the reactive power. A cost analysis reveals that the cost of synchronous compensation on the basis of active power is lower than with special-purpose synchronous compensator or operation under no load. Figures 4, table 1, references 3 Russian.
[181-2415]

UDC 621.311.22.002.51.016.3.003.1

COST EFFECTIVENESS OF BOILER SET IN 800 MW POWER UNIT OF UGLEGORSK GRES
OVER WIDE LOAD RANGE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 82 pp 12-14

LARIONOV, V. F., engineer, SUROVOV, A. Ye., engineer, AVDEYEV, I. A., engineer, and CHUPROV, V. V., engineer, Donetsk Regional Engineering Administration of Power System Management; All-Union Institute of Heat Engineering

[Abstract] A study was made to determine the cost effectiveness of a boiler set in an 800 MW power unit at the Uglegorsk GRES. The technical-economic parameters of such a boiler set operating with grades 40 and 100 fuel oil (heating value 40-40.5 MJ/kg, sulfur content 2.2-3.0%, moisture content 1.2-2.8%) were measured under loads varying from 50 to 100% nominal. These parameters include electric energy and heat expended on plant auxiliaries (air heater, feed pumps, ventilating fans), total heat loss in the boiler, heat escaping with flue gases, and gross boiler efficiency. The results indicate that the boiler set is cost effective within the 70-100% load range and operates with maximum efficiency (88.25%) at a load of 600 MW. With control of fuel burnout and soot concentration by installing nozzles with cermet atomizers, the combustion chamber can be made to operate economically with excess air ratio of less than 1.02. Figures 2, table 1.

[181-2415]

INDUSTRIAL TECHNOLOGY

UDC 621.9.077.52

AUTOMATIC COMPLEXES FOR MACHINING PARTS WITH SURFACES OF REVOLUTION

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 17-18

KUZNETSOV, Yu. I.

[Abstract] Modern equipment of machine tool and automatic manipulator technological complexes includes not only automatic interchange of tool bits but also chucks with automatically interchangeable jaws for accomodating blanks of diverse shapes and sizes, as well as for rough and finish cutting, without intervention of the human operator. Such a set is the U-NC316 (Forkhardt GmbH, West Germany) automatically changing jaws for the MD5 (Max Muller GmbH, West Germany) lathe with digital programmed control. The cartridges holding the interchangeable jaws (chain, ring, drum, or disk) can be placed on or next to the lathe. The positioning of the blank in the chuck after a change of jaws is checked for the automatic manipulator by special sensor gauges. Figures 4, references 5 Western.
[174-2415]

UDC 007.52:631.3

EXPERIENCE IN USE OF AUTOMATIC MANIPULATORS IN ENTERPRISES OF MINISTRY OF AGRICULTURAL MACHINERY MANUFACTURE

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 14-16

ZHIRNOV, Ye. A.

[Abstract] Automation of the manufacture of agricultural machinery such as tractors during the 1975-1980 period is best exemplified by developments in the metal cutting sector, where the amount of equipment in stock is larger than that in stock for forging, casting, and welding taken together. Replacement of manual labor has proceeded in three stages: 1) general-purpose machine tools with some basic and auxiliary operations remaining manual; 2) semiautomatic special-purpose and aggregate machine tools with

only loading and unloading still manual; 3) fully automatic machine tools without manual labor, except at the start and the end of the line. Automatic manipulators with programmed control now in operation in metal cutting plants include, in addition to those also used in other sectors of the metal forming industry, also several developed by and for the metal cutting sector. They are the R-505 for machine tools with horizontal spindle, the RPG-1M with a small arm but longer travel (750 mm) for sheet metal stamping, the MAN-63 with as many as seven positioning points for transport and warehouse operations, the KSh series (load capacities of 63, 100, 160, 250 kg) balancing automatic manipulators with a pneumatic cylinder for balancing the lifted weight for free vertical as well as horizontal movement and rotation about the axis of suspension, the MK-63 balancing automatic manipulator with an additional pantograph to ensure the necessary sloping of a blank before it is gripped and its subsequent fast positioning, and the experimental R-500 with two arms and full rotation for large-scale and mass production. Figures 5.

[174-2415]

UDC (658.011.56;621.941):007.52

AUTOMATIC LATHE SEGMENT FOR MACHINING LARGE SHAFTS FOR ELECTRIC MOTORS

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 12-13

KIRSANOV, V. V., BATRAKOV, S. G. and KUZNETSOVA, S. G.

[Abstract] A lathe segment is in operation at the Moscow Electrical Machinery Plant "Dynamo" imeni S. M. Kirov for machining large motor shafts. It consists of two milling-centering machines MR-179, two semi-automatic lathes 1B732F2 with an N22-1M system of digital programmed control, and an automatic manipulator UM160F2.81.01 with auxiliary equipment. It performs the entire cycle of operations on 700-1500 mm long shafts (weighing 40-160 kg) with diameters stepped from 8 to 130 mm, with tapers and chamfers as well as threaded ends. The segment operates according to a flexible program consisting of three subprograms (queuing, loading, unloading) in any sequence required. Special devices have been installed to ensure failure-free, safe and reliable operation of the automatic manipulator. Experience reveals that shutdowns are caused by trouble in the digital programmed control (25%), other troubles in the machine tools (10%), failure of the automatic manipulator (7%), failure of safety system (1%), errors in programming (48%), and breakage (9%). The segment replaces six workers on a two-shift basis and increases the productivity eightfold, with an annual output of 32,000 pieces of 30 different shafts. Figures 2.

[174-2415]

UDC 621.9.077:007.52

SIZE STANDARDIZATION OF BASIC COMPONENTS FOR TELPHER-TYPE AUTOMATIC MANIPULATORS

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 10-11

KOZYREV, Yu. G. and NAKHOV, M. B.

[Abstract] A telpher-type automatic manipulators consists of a carriage and an arm with a tong moving on a monorail between two support columns. A rational size standardization of the monorail and the support columns has been established at the Experimental Scientific Research Institute of Metal Cutting Machine Tools on the basis of about 500 existing models of machine tools in three major categories: light, medium, heavy and the corresponding series of 0-10 kg, 10-40 kg, 40-160 kg automatic manipulators. The choices of standard monorail lengths and column heights are based on the distributions of machine tools with respect to length, length+clearances (800 mm) for accessibility, and height. The choices cover at least 90% of all machine tools in the respective category. Since there is some overlap in dimensions between the categories of machine tools, some monorails can be the same for different manipulator sizes. The recommendations are accordingly: 4000 mm and 5000 mm monorails for light machine tools; 5000 mm and 6300 mm monorails for medium and heavy machine tools; 2000 mm support columns for light machine tools; 2500 mm support columns for medium and heavy machine tools. Figures 4, references 2 Russian.

[174-2415]

UDC 621.9.077:007.52

ANALYSIS OF LAYOUT SCHEMES FOR ROBOTIZED COMPLEXES

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 7-8

VELIKOVICH, V. B.

[Abstract] In existing robotized technological complexes the automatic manipulator performs operations that amount to approximately 20% of the entire production process. Planning is underway to increase this fraction to 50%. In the case of metal cutting processes, where an automatic manipulator operates either one machine tool or several, the foremost requisite is to introduce digital programmed control. Already approximately 420 models of machine tools can be recommended for robotization, with automatic manipulators of a 10-40-160 kg parametric series of rated load capacities most economically covering the entire range of parts sizes. The technological complex is usually laid out circularly for floor mounted automatic manipulators or linearly for overhead ones. The latter layout offers several advantages, namely requires less production space for the same number of machine tools and auxiliary equipment, it is more accessible to inspection, and does not require total shutdown for repair or adjustment of one component.

The number of machine tools that can be included in a linear complex is determined principally by the machining time, while usually not more than only two machine tools can be included in a circular complex. Finally, there is no constraint on the horizontal travel of the manipulator arm in a linear complex. Figures 2.

[174-2415]

UDC 007.52

ENGINEERING DIAGNOSIS OF ROBOTIZED COMPLEXES

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 5-7

OSTAPCHUK, V. G. and CHERTKOV, B. M.

[Abstract] First experience with robotized technological complexes has already established a direct relation between labor productivity and relative failure-free operating time of automatic manipulators. It is, therefore, expedient to include in the robotized technological complex a special inspection system for preventive automatic troubleshooting. Such a system is interfaced with a computer through appropriate software. The algorithm of diagnosis includes determination of the initial state, a test run, and determination of the state at any given time in the terms of capability of the complex to execute its technological program of operations and through comparison with its initial state. This system constitutes the upper level of robot complex control, with processing of data from critical complex components and with output to the operator's panel, with subprograms and routines that facilitate execution of the diagnosis process. Figures 3, references 3 Russian.

[174-2415]

UDC 658.382.3:007.52.004

WORK SAFETY IN ROBOTIZED COMPLEXES

Moscow STANKI I INSTRUMENT in Russian No 1, Jan 82 pp 3-5

KANAYEV, Ye. M. and KOZYREV, Yu. G.

[Abstract] Protective measures for ensuring personnel safety during operation and maintenance of automatic manipulators in robotized technological complexes, specifically machine tool complexes, are tailored to each of the three basic types of such complexes: those where the human operator has no access to the activity zone of the automatically operating manipulator (machine tools with built-in automatic manipulators), those where the activity zones of human operator and automatic manipulator overlap ("machine tool - automatic manipulator" complexes, first-generation complexes with one automatic manipulator operating several machines according to a

rigid control program), and those where the two zones remain separate. Special devices for ensuring accident-free operation of any such complex have been developed at the Experimental Scientific Research Institute of Metal Cutting Machine Tools. They include devices for checking that the control program has been executed to completion, devices for inspection of blanks to be gripped by the manipulator arm and for stopping the arm movement when forces larger than maximum permissible act on it, and logic-control interlock devices responding to optical signals and actuating guard and bypass structures. Additional measures contributing to safety are adaptive control of automatic manipulators and preventive diagnosis of the robotized technological complex for operating fitness.

[174-2415]

UDC 62-82:007.52

DYNAMICS OF DIGITAL ROTATING PNEUMATIC DRIVE FOR AUTOMATIC MANIPULATOR

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 2, Feb 82 pp 11-13

KOPP, V. Ya., engineer, and POGORELOV, B. V., candidate of technical sciences

[Abstract] A pneumatic drive for an automatic manipulator is considered that consists of several torquing cylinders connected sequentially so that the shaft of each preceding one rotates the body of the following one. Its accuracy and response speed can be optimized by design and selection of the control law on the basis of the solution to the system of differential equations of motion, thermodynamics and impact for its moving elements. Such a mathematical model was constructed for a digital three-vane rotating pneumatic drive and the equations were solved, with damping taken into account, for the most important case of maximum travel angle of the output shaft. An automatic manipulator with three sectoral torquing cylinders and digital control was designed on this basis for feeding flat parts to an assembly point at a rate of 18 parts per minute. Figures 3.

[172-2415]

UDC 621:007.52-231.1

STRUCTURE OF AUTOMATIC MANIPULATORS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 2, Feb 82 pp 7-11

KRASNIKOV, V. F., candidate of technical sciences

[Abstract] The technico-economic characteristics of automatic manipulators operating as industrial robots are largely determined by their structure and

kinematics. Here two such devices for pressure casting are examined from this standpoint: one with closed cyclic structure for transfer of castings from mold cavities to cooling facility and subsequent treatment, one with open acyclic structure including a telescopic system for removal of castings from mold cavities. The action of kinematic pairs and interlinkages can be analyzed by representing the structure in the form of finite sets, in the form of relations, in the form of a contiguity matrix, in the form of numerical sequences, in an algebraic form of equations, in the form of rational fraction expressions, and in the form of characteristic power polynomials. The choice of a manipulator structure from the set of alternatives is most expediently made with the aid of a computer with storage of data on all possible kinematic schemes according to these representations. Figures 2, references 3 Russian.

[172-2415]

UDC 621.007.52

PROMISING TRENDS IN COMPLEX AUTOMATION BASED ON USE OF AUTOMATIC MANIPULATORS IN MACHINE MANUFACTURE

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 64-65

PANOV, A. A., candidate of technical sciences, deputy general director, "Orgstankinprom" Scientific-Industrial Association; chairman, Commission on "Industrial Robots and Manipulators" at the Committee on Automation and Mechanization of Production Processes, All-Union Council of Scientific and Technical Societies

[Abstract] An international symposium on producing automatic complex machine tool systems and use of robots was held in Plovdiv (Bulgaria) 9-10 June 1981 by 186 Bulgarian specialists, with participation of Soviet, East German, Czechoslovak, Polish and West German specialists. The reports reveal that in Bulgaria the latest achievements are still under-utilized, robotization is proceeding at a slow pace, and the reliability of robot system components is still low. Following the presentation, several resolutions were adopted concerning a national program on large-scale automation for Bulgaria in conjunction with development of special-purpose machine tools with programmed and digital programmed control, updating associated electrical and electronic equipment, training of technicians and engineers, devising instruction programs at the academic level, devising methods of cost effectiveness evaluation, cooperation with the Soviet scientific-engineering community and those of other socialist countries, and regular review of outstanding problems jointly with the machine tool industry. Formation of a coordinating council was proposed for ensuring a most efficient robot development and production process.

[171-2415]

MODEL RKTB AUTOMATIC MANIPULATORS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 1, Jan 82 pp 6-8

PLOTNIKOV, A. V., engineer, and MIRESHKIN, V. A., engineer

[Abstract] Model RKTB-1,3 automatic manipulators for cold stamping were built in 1979, followed by model RKTB-6 in 1980 and model RKTB-7M in 1981. The RKTB-1 has one arm with 1 kg load capacity and four degrees of freedom, a clamp tong and electronic controls. The RKTB-3 has two arms with 0.3 kg load capacity each and three degrees of freedom, vacuum-suction tongs and control through a 24-slot drum rotating at 1/6 rps driven by an induction motor through a speed reducer. The RKTB-6 has two arms with 0.3 kg load capacity each and three degrees of freedom, vacuum-suction tongs and electronic controls. The RKTB-7M has one arm with 0.8 kg load capacity and two degrees of freedom, a vacuum-suction tong and electronic controls. All are energized from an industrial 0.4-0.6 MPa pneumatic power line and an industrial 220 V \pm 10% - 50 Hz electric power line (except the RKTB-7M, which operates from a three-phase 380 V \pm 10% - 50 Hz electric power line). Pneumatic and hydraulic dampers, brake cylinders, lifting and turning mechanisms are still undergoing improvements. All models are being thoroughly tested for reliability, their MTBF is now 500 h. Figures 6, table 1.

[168-2415]

UDC A621.7.077.621:658.2(043)

SPECIALIZATION OF TRENDS IN INDUSTRIAL ROBOTS DEVELOPMENT

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 1, Jan 82 pp 35-36

KOZLOV, A. A., bureau chief

[Abstract] The author discusses the article "Conditions for Introduction of Automatic Manipulators into Machinery Manufacturing Process" by V. P. Bobrov in MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA No 4, April 1981. He disagrees with some of the premises concerning terminology and classification. The term "industrial robot" is preferred as a more general and far reaching one, while the term "automatic manipulator" is applied to the simplest first-generation device. Industrial robots thus include also sensorized ones (second generation), adaptive ones (third generation) and programmable ones (fourth generation). They will also include new versions. The possibility is considered that an automatic manipulator will disappear as a separate entity in a technological complex with automation of auxiliary operations already designed into the machine tool. The trend toward technological complexity of industrial robots is illustrated

by some built in the Soviet Union (Kontur-002, PRK-20, UNIVERSAL-15, RF-202M, RF-204M). This trend is necessarily linked to a trend toward more specialization and, at the same time, standardization. Solution of problems involved in developments along these lines will require improvement of existing technologies and search for new ones.
[168-2415]

UDC 621.7.077.621:658

CONDITIONS FOR INTRODUCTION OF AUTOMATIC MANIPULATORS INTO MACHINERY MANUFACTURING PROCESS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 2, Feb 82 pp 38-39

FEDOTOV, A. V., candidate of technical sciences, department head at Omsk Polytechnic Institute

[Abstract] The author discusses the article under this title by V. P. Bobrov in MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA No 4, April 1981. Unlike V. P. Bobrov, this author interprets the resolution by the 25th CPSU Congress with regard to increased production as implying not only quantitative but also qualitative progress. The history of the "robot" and its gradual introduction as an automatic manipulator into the machinery manufacturing industry are reviewed with emphasis on computer-aided programmable and adaptive control. According to present trends, such a system should by the year 2000 reduce the industrial labor force to 3% of the able population. The problem of replacement of human labor is discussed in terms of robot capability. The basic three conditions for such a replacement are 1) organization of series production of sufficiently large volume with satisfactory technical characteristics; 2) availability of trained engineers and technicians, 3) classification of robots for their target-oriented development and production. Successful robotization of the production process will depend on maximum utilization of experience already available, including experience in development and installation of machine tools with digital programmed control, as well as on adequate plant and equipment reorganization and layout to accommodate a robot physically much larger than man, with full utilization of the robot's unique capability to operate continuously for long periods at the same task. The author foresees robots not only in mass production but also in batch production and even in manufacture of custom-made products.

[167-2415]

UDC A62-229-7:621.777.4

TECHNOLOGICAL COMPLEXES WITH AUTOMATIC MANIPULATORS FOR STAMPING
TELEPHONE SET COMPONENTS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russ. in o 2,
Feb 82 pp 1-3

ENTIN, V. I., candidate of technical sciences, STRODS, V. Ya., engineer,
NIKOLAYEV, V. V., engineer, and BENGARD, I. A., engineer

[Abstract] Automatic manipulators have been installed at the Riga State Electrotechnical Works imeni V. I. Lenin for secondary stamping of frequently interchangeable parts such as caps and other telephone set components. The technological complex includes a PMR-0.6 automatic manipulator with electromagnetic or pneumovacuum tongs for ferrous and nonferromagnetic parts respectively, a vibratory hopper, and a stamping press with slider feed. The manipulator operates cyclically and is driven by a pneumatic motor with positioning on rigid guides. Mechanical dampers are provided for softening the impact at each end of travel of servomechanisms, one damper per degree of freedom. Contactless transducers and control logic, immune to changes in ambient conditions, ensure reliable and safe operation of the manipulator arm with necessary interlocking, particularly precise positioning of blanks in the die and timely smooth removal of finished parts from the stamping zone. Figures 6.

[167-2415]

UDC 62-50:007.57

MODELING MANIPULATOR ROBOT MOTIONS FROM GIVEN TRAJECTORIES

Moscow MODELIROVANIYE I OPTIMIZATSIYA SLOZHNYKH SISTEM UPRAVLENIYA
in Russian 1981 (signed to press 8 Jun 81) pp 216-222

MANOLOV, O. B. and TULEPBAYEV, V. B.

[Abstract] An adaptive algorithm for controlling a manipulator robot by a hybrid computer system is developed on the basis of a combination of three principles of control: dual (Ya. Z. Tsypkin, "Adaptatsiya i obucheniye v avtomaticheskikh sistemakh" [Adaptation and Learning in Automatic Systems], Moscow, Nauka, 1968), piecewise-terminal (D. Ye. Okhotsimskiy, Yu. F. Golubev, L. A. Alekseyeva, "Algorithm for Stabilizing Motion of Automatic Legged Vehicle" in: "Upravleniye v prostranstve" [Control in Space], Vol 2, Moscow, Nauka, 1976), and combined (A. A. Petrov, I. M. Perfil'yeva, "Controlling Motions of Manipulator Robots by Hybrid Computer Systems" in: "Vtoroye Vsesoyuznoye soveshchaniye po problemam upravleniya" [Second All-Union Conference on Control Problems], Vol 1, Minsk, 1977). Formulation of the algorithm is based on the following requirements: the algorithm must ensure evaluation of the changes in

parameters of the control object and the environment acting on the object; a programmed control module must provide appropriate changes in control signals; when the situation requires it, the algorithm must modify the programming of the trajectory generator module. When these requirements cannot be met, a higher level must be informed that the assigned task cannot be carried out. In addition to the trajectory generator and the programmed control module, the system contains a simplified model of the control object, an adjustment module and a corrector. Controlling signals go simultaneously to the control object and the model, and the mismatch is used as input data for calculating necessary adjustments, after which the corrector generates the corrective actions to minimize the mismatch. It is shown that a system with adaptive adjustment is most effective. Figures 3, references 8 Russian.

[138-6610]

UDC 62-50

USING ADAPTIVE DYNAMIC MODEL IN CONTROL LOOP OF ROBOT ACTUATING UNIT

Moscow PROBLEMY UPRAVLENIYA V TEKHNIKE, EKONOMIKE, BIOLOGII in Russian
1981 (signed to press 13 Aug 81) pp 162-170

MANOLOV, O. B.

[Abstract] The author suggests an algorithm of parametric adaptation to changes in physical parameters of the actuating units of manipulation robots in an adaptive combined control system that contains a programmed motion generator for formulating laws of change in angles, velocities and accelerations of the actuating element, an inverse model of the object that generates the appropriate controlling actions for input to the object of control, a regulator that corrects the controlling actions to minimize mismatch between generated controls and those actually realized, and a module that realizes adaptation to the changing vector of parameters of the object when the law of change is not known beforehand. The latter module uses an algorithm of identification based on the behavior of a simplified model of the object of control in combination with switches and a memory device to minimize a given criterion functional. A brief examination is made of a system with hybrid computer that realizes the proposed algorithm in real time. Figures 4, references 11 Russian.

[139-6610]

FORMATION OF PROGRAMMED MOVEMENTS OF MANIPULATION ROBOT

Moscow PROBLEMY UPRAVLENIYA V TEKHNIKE, EKONOMIKE, BIOLOGII in Russian
1981 (signed to press 13 Aug 81) pp 191-196

TULEPBAYEV, V. B.

[Abstract] An examination is made of the use of a combined control system for generating laws of variation in generalized coordinates corresponding to performance of a given motion trajectory by the actuating units of a robot manipulator, and for determining the controls on drives to realize these laws. Such a system contains a module that generates controlling signals for the drives of the manipulator depending on the necessary angular displacements, velocities and accelerations with consideration of the dynamic properties of the manipulator and drives based on solution of the inverse problem of dynamics, using a simplified dynamic model of the actuating unit, and a module that generates correcting actions based on the current and required values of the generalized coordinates. A system is developed for forming programmed changes in generalized coordinates that would generate trajectories acceptable for the combined control system. The signal input may be manual, or may come from higher levels of the hierarchical robot control system. Figures 5, references 10: 9 Russian, 1 Western.
[139-6610]

TURBINE AND ENGINE DESIGN

UDC 621.165.001:539.433

IMPROVED OPERATIONAL RELIABILITY OF TURBINE BLADING

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 82 pp 17-19

KUZNETSOV, A. L., doctor of technical sciences, STEPANOV, A. M., candidate of technical sciences, OSTROVSKIY, L. I., candidate of technical sciences, and OSTASHKOV, A. I., engineer

[Abstract] Blades for NZL ("Nevskiy" Plant, Leningrad) gas turbines are made of EI893 alloy steel, their fatigue strength under symmetric cyclic loads having been found to decrease from 167 MPa at room temperature to 152 MPa at operating temperatures and under lateral loads. In order to recover the necessary safety margin, stresses under the most unfavorable conditions were estimated, taking into account sudden application and removal of the full force as well as impulses and variable forces exerted on blades by trails behind the guide vanes. Theoretical calculations on the basis of this approximate estimate and subsequent measurements with strain gauges in experiment under field conditions have revealed that overlapping of guide channels is a major cause of extra stresses during vibrations at the fundamental frequency. Measures taken to prevent overlapping, while not affecting the high-frequency stresses caused by edge trails, have improved the reliability of the blading by reducing the amplitude of resonance vibrations. Figures 4, references 5 Russian.
[177-2415]

UDC 621.515.001.2

MAIN TRENDS IN TURBOMACHINERY RESEARCH

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 82 pp 5-8

SARANTSEV, K. B., engineer

[Abstract] Development of economical gas and steam turbines and axial as well as centrifugal compressors for operation under heavy loads is closely linked to new theoretically conceived and experimentally tested

ideas pertaining to aerodynamics, mechanical strength, combustion, heat and mass transfer. It has been established, for instance, that the efficiency of a turbine stage depends on the Reynolds number but not on the Mach number up to $N_M = 1.2$ and that losses in a turbine stage with high entrance temperature can be reduced by means of a blade-type diffuser behind the moving blades. It has also been found possible to perfect the aerodynamic profiling for operation at transsonic air velocities, to improve the welding of blades, and to reduce the number of moving stages without loss of efficiency by using three-dimensionally profiled blades and running them at higher speed. New design methods have been developed for reducing stress and vibration, along with new methods of measuring them in the laboratory and in the field. Special attention is paid to balancing of runners. An outstanding improvement in the design of the combustion chamber is microflame burning with simultaneous mixing, which not only decreases the size of the combustion zone and reduces the concentration of nitrogen oxides in the flue gases but also reduces undesirable vibrational burning at acoustic resonance frequencies. Heat and mass transfer is improved by more effective channeling and finning of the heat-exchange surfaces, also by a new highly efficient (70%) light-weight (6.75 t) air preheater-regenerator. Development of air and gas coolers for operation at temperatures up to 400°C and pressures up to 2.5 MPa is still in progress. Major contributors to this progress are Central Institute of Boilers and Turbines imeni I. I. Polzunov, Central Scientific Research Institute of Machine Building Technology, Leningrad Polytechnic Institute, Moscow Institute of Power Engineering, Institute of Electric Welding imeni Ye. O. Paton and Planning Department at the "Nevskiy" Plant. Figures 5.

[177-2415]

UDC 621.224.24.001

SPACE AND DISK LOSSES IN RADIAL-AXIAL WATER TURBINES

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 82 pp 11-14

MAKAROV, V. V., engineer, PYLEV, I. M., candidate of technical sciences, and P'YANOV, V. I., engineer

[Abstract] Disk losses (due to friction between liquid and external surfaces of revolution) and space losses (due to leakage through clearances and seals between stationary and moving parts) have been calculated for several model turbines in the following hydroelectric power plants: Balimel ($n_s = 99$), Sayano-Shushenskiy ($n_s = 186$), Mayka ($n_s = 171$), Toktogul ($n_s = 212$), Ust'-Ilimskiy ($n_s = 276$), Aswan ($n_s = 301$), Capivari ($n_s = 360$), and Volkhov ($n_s = 425$, prototype). The calculations were made according to semiempirical formulas based on Bernoulli's equation and dimensional analysis, taking also into account deviations from similarity. Nomograms have been constructed on the basis of these calculations, for use in both design and testing. Figures 4, references 9 Russian.

[177-2415]

STABILITY OF VIBRATION ISOLATORS IN TURBOGENERATOR STATOR WITH RIGIDLY MOUNTED CORE

Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 81 (manuscript received 5 Dec 80)
pp 5-7

BARBASHIN, L. N., engineer

[Abstract] Stators in 300 and 500 MW turbogenerators of the TVM series, unlike those of other series, have their cores mounted rigidly with a tight fit produced by means of opposing wedges between the core and the tie prisms. Vibration insulation of such a stator is ensured by flat springs mounted vertically, preferably at the radius where the tangential displacements are zero. For design of such vibration isolators and evaluation of their performance, the mechanical system is assumed to consist of two isotropic homogeneous long cylinders, one inside the other, separated by stiff elastic couplings. The radius R_0 of zero tangential displacements is calculated as a function of the coupling stiffness. A stability analysis based on the corresponding fundamental equations of stator motion according to the theory of thin rings and the A. M. Lyapunov method indicates that such vibration isolators in TVM turbogenerators will remain stable when mounted at a radius R within ± 0.07 m of the radius R_0 in the case of a perfectly rigid core mounting. For a more compliant core mounting the practical range of radius R is within $\frac{4}{3} R_m \pm 0.07$, where $R_m = \frac{1}{2}(r_0 + r_s)$ (r_0 - outside radius of the stator housing, r_s - radius at the bottom of stator slots). Figures 2, references 4 Russian.

[179-2415]

AXIAL COMPRESSORS FOR GTN-25 GAS TURBINE PLANT

Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, Dec 81 pp 18-20

BOGORADOVSKIY, G. I., candidate of technical sciences, TITENSKIY, V. I., candidate of technical sciences, OLIMPIYEV, A. V., engineer, and POLYAKOV, V. S., engineer

[Abstract] The axial compressor for GTN-25 gas turbine plants consists of an 8-stage low-pressure unit and a 7-stage high-pressure unit. Prototypes for the design were respectively the GT-100-750-Z LMZ (Leningrad Metal Works) low-pressure model and the conventional transportation-type high-pressure model. Both units were tested at 0.9 full speed in aerodynamic and vibrations test stands with a harmonic analyzer, as well as at the Novgorod experimental laboratory. The adiabatic efficiency of both reaches 88%. The nominal compression ratio delivered by the set is 12.5 at a polytropic efficiency of 90.4%. Figures 4, references 5: 4 Russian, 1 Western.

[178-2415]

CENTRIFUGAL COMPRESSORS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, Dec 81 pp 16-17

ARKHIPOV, V. V., chief compressor designer, MAGDYCHANSKIY, V. S., engineer, KAMENEV, V. M., engineer, and SHISHKOV, L. I., engineer

[Abstract] Centrifugal compressors designed and built by the "Nevskiy Plant" Industrial Association imeni V. I. Lenin cover the range of 0.6-500 m³/s capacity at pressures from 0.01 to 30 MPa. They are driven by electric motors ranging in size from 600 to 20,000 kW respectively. Development of and specialization in the manufacture of such compressors at this plant began in 1933. Achievements in the last 25 years include air compressors with 4.1-50 m³/s capacity at pressures from 0.765 to 1.42 MPa, 500 m³/s compressors for gas turbines, agglosuperchargers with 66.6-200 m³/s capacity at up to 0.013 MPa pressures for operation in dusty environment, special-purpose compressors for the ferrous metallurgy and for the petrochemical industry, also general-purpose compressors. The main design objectives have been raising the efficiency, lowering the metal content, and reducing the size. A typical feature accomplishing this is a blade-type diffuser. The first units of new models are usually thoroughly tested at the user's plant. Natural-gas superchargers, for instance, are tested at the Novgorod experimental laboratory. Latest centrifugal compressors will be shown at the next Exhibition of Achievements of the USSR National Economy. Figure 1.

[178-2415]

NAVIGATION AND GUIDANCE SYSTEMS

UDC 531.383

USE OF ACCELEROMETER READINGS FOR DAMPING NATURAL VIBRATIONS OF TWO-WHEEL GYROCOMPASS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 1, Jan 82 (manuscript received 12 Feb 81) pp 45-47

KALINOVICH, V. N., Institute of Mathematics, UkrSSR Academy of Sciences

[Abstract] The author considers the feasibility of damping the natural vibrations of a two-wheel gyrocompass with hydraulic stabilizers on the basis of accelerometer readings and data on the divergence angle between the wheels. Basically three accelerometers measure and read continuously the projections of apparent accelerations on the three axes of the sensing element. The equations of precession for the sensing element are reduced to a form where the divergence angle still appears but the moments of all forces have been replaced by apparent accelerations and stabilizer design parameters. The equations of work for the stabilizers are reduced to first-order linear differential equations solvable by a computer. With the principle established, damping schemes are mathematically simulated that require readings of only two accelerometers or readings of only one accelerometer and the divergence angle. The article was presented by Academician Yu. A. Mitropol'skiy, UkrSSR Academy of Sciences.

References 5 Russian.

[173-2415]

UDC 620.1.05:531.24(088.8)

AUTOMATED BALANCING OF DYNAMICALLY TUNABLE GYROSCOPES

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 1, Jan 82 pp 3-5

SUMINOV, V. M., doctor of technical sciences, BARANOV, P. N., candidate of technical sciences, and OPARIN, V. I., engineer

[Abstract] A typical dynamically tunable gyroscope consists of an inner wheel mounted on a motor-driven shaft and coupled through elastic torsion

bars to an outer ring in a Cardan joint. It is possible to determine the unbalance masses in two correction planes, reduce the calculated three unbalance masses in two correction planes, reduce the calculated three unbalances (static, axial, moment) they produce to three resultant vectors uniquely located on the wheel surface, and remove those unbalance masses simultaneously by means of a laser beam. The error due to interaction of unbalances is thus eliminated, which makes it easy to automate the balancing process with the aid of a computer. The method is, accordingly, more precise and more efficient than sequential removal of unbalance masses. Experimental balancing of five gyroscopes has further revealed that in this method 50-60% less material needs to be removed by the laser beam than in the sequential balancing method. Figures 2, table 1.

[168-2415]

FLUID MECHANICS

UDC 539.3

RESONANT SCATTERING OF BOUNDED SOUND BEAM BY ELASTIC SPHERE IN ACOUSTIC MEDIUM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 1, Jan 82
(manuscript received 24 Mar 81) pp 51-54

PODUBNYAK, A. P.

[Abstract] The resonance theory developed in nuclear physics to explain some anomalies in the spectral characteristic of acoustic pressure wave produced by scattering of a narrow unidirectional sound beam by elastic spherical objects is generalized to scattering of a bounded sound beam by an elastic solid sphere. The incident wave is assumed to form a narrow conical beam coaxial with the sphere. The analysis, with the S-function represented in resonant form according to the Breit-Wigner theory, and numerical calculations reveal that each partial wave has an infinite series of resonances. They also reveal another kind of anomaly associated with amplification and attenuation of resonance amplitudes due to changes in the transverse dimensions of the sound beam. The article was presented by Academician Ya. S. Podstrigach, UkrSSR Academy of Sciences. Figures 3, references 10: 3 Russian, 7 Western.

[173-2415]

TESTING AND MATERIALS

UDC 621.336:621.762.862

NEW SLIP RING MATERIAL FOR SLIDING CONTACTS IN ELECTRICAL TRANSPORTATION EQUIPMENT

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 21-24

BERENT, V. Ya., candidate of technical sciences, KRUMINYA, M. Yu., engineer, SHCHERBA, Yu. N., engineer, and BEL'DEY, V. V., engineer

[Abstract] A series of iron-copper alloys, with 1% Ni for activation of the sintering process, was prepared for evaluation as slip ring contact materials with 170-250 A/cm² current capacity in electrical transportation equipment. The alloys had been selected on the basis of the iron-copper phase diagram. Sintered specimens were impregnated with fusible CO5 alloy (95% Pb + 5% Sn) under a pressure of 6.0-8.0 MPa after prevacuumization, examined for porosity and distribution of lead inclusions, then tested for antifriction characteristics in rubbing against copper at a speed of 0.41 m/s under a pressure of 0.7 MPa. A copper content of 5-10% was found to yield optimum characteristics, the high porosity here allowing for large addition of solid lubricant (22-27.6% Pb correspondingly), but enough hardness and mechanical strength. The alloy with 15% Cu was finally selected as the best tradeoff and slip ring specimens of this material for contact plates in railroad equipment were tested at the Institute of Metals Science imeni Blagonravov, in duty cycles at speeds from 0.12 to 5 m/s with a current of 75 A passing through the contact under a pressure of 0.2 MPa. Dry lubricant (35-39% coumerone resin with 61-65% pencil graphite) was added and then depleted in dry friction. In rubbing against a copper mating element, this slip ring material exhibits excellent self-lubrication characteristics. Replacement of the existing VZh1 alloy (69% Fe, 22% Cu, 7% Pb + 2% VN) with the new VZh3 alloy in a changeover to d.c. electric traction should result in a longer life of contact plates and an economic effect of over 1 million rubles annually. Figures 3, table 1, references 2 Russian.

[171-2415]

FILLED FLUOROCARBONPOLYMERS FOR SLIDING BEARINGS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 17-21

SEmenov, A. P., doctor of technical sciences, ISTomin, N. P., candidate of technical sciences, YERMAKOVA, Z. M., engineer, and BABICHEVA, P. G., engineer

[Abstract] An experimental study of Teflon-4 and other fluorocarbonpolymers was made to determine their friction characteristics, namely the dependence of friction and wear without lubrication on various operating conditions (rubbing speed, load, temperature, radiation) and on the filler parameters (composition, concentration, dispersion, grain shape and orientation). Filler materials were graphite, molybdenum sulfide, barium sulfide, copper, bronze, aluminum, titanium, molybdenum, lead, talcum, silica, or glass-ceramic in optimum amounts of 15-30%. The tests were performed with "round shaft - flat seal" pairs, most at room temperature at rubbing speed of 0.5 m/s under load of 400 N, some over a wide speed range (0.002-2.5 m/s) and a wide temperature range (20-150°C), also under a light load of 200 N but without letting the specific load drop below 5 MN/m² due to wear. Figures 6, tables 3, references 7 Russian.
[171-2415]

USE OF AFRICITION ELASTOMERS IN MACHINE DESIGN

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 15-17

DUKHOVSKOY, Ye. A., doctor of technical sciences, KLEYMAN, A. M., candidate of technical sciences, SKOK, V. M., engineer, and KHOMYAKOV, A. V., candidate of technical sciences

[Abstract] A plasmochemical method of inoculating the surface of elastomers with an afriiction layer has been developed that reduces the friction coefficient to 0.3-0.1 and makes the material most suitable for vacuum seals on moving parts such as clocks manufactured at the Moscow Clock Works imeni S. M. Kirov. The performance of thus modified SKF-26 fluoroelastomer and SKN-26 polyurethane rubber was evaluated experimentally by measuring the dependence of the air leakage rate on the shaft speed and of the friction force on the shaft temperature as well as the friction force and the oil leakage rate as functions of time. The results indicate that, while the surface properties are improved (lower friction and wear), the bulk properties (heat and frost resistance) remain almost unchanged. Figures 6, table 1, references 3 Russian.
[171-2415]

UDC 62-762.424

DESIGN OF TEFLON-4 FROST RESISTANT RADIAL SEALS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 12-15

CHERSKIY, I. N., doctor of technical sciences

[Abstract] A multipurpose collet-type sleeve seal has been developed at the Institute of Physico-Technical Problems of the North (Yakutsk branch, USSR Academy of Sciences) with Teflon-4 chosen as the most suitable frost resistant and chemically inert antifriction material. Here the design of such a seal is shown based on theoretical pressure-velocity and wear-friction-temperature characteristics as well as on experimental data on this and other materials. The optimum concentration of filler material depends on the intended operating conditions and in this case Teflon-4 with (2-3)% graphite is found to be superior to Teflon-4K20 with 20% coke. The design method was developed in collaboration with V. A. Morov. Figures 5, references 4 Russian.

[171-2415]

UDC 621.822.5:678.5

EFFECTIVE USE OF METAL-FLUOROPLASTIC BEARINGS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 9-12

SEMENOV, A. P., doctor of technical sciences

[Abstract] The important advantages of metal-fluoroplastic bearings are elimination of the lubricant with resulting economy in use of petrochemicals, reduction of size with resulting economy in use of scarce nonferrous metals and alloy steels, resistance to fritting-corrosion and brinelling, which improves the reliability, and wide range of safe operating temperatures (-200°C to +300°C) in air and in aggressive media as well as in vacuum. These advantages derive essentially from the excellent antifriction characteristics of Teflon-4 combined with its chemical and biological inertness. Such bearing are produced in two technological variants: molded into individual intricate configurations or stamped from strip stock. Their size is determined essentially by the pv (MPa.m/s) product and the operating temperature. They have already found wide applications such as aircraft and automobiles, machinery for light industry and the food industry, and pumps for oil drilling. They can be used with substantial cost effectiveness in equipment for practically every application, including medical equipment, in any climate and particularly in the cold regions, also in transportation. Their technology has been developed and their production organized by the All-Union Scientific Research Institutes of the Automobile Industry and the Textile Industry, at the Klimovsk Machine Manufacturing Plant and other enterprises. Figures 4, references 7 Russian.

[171-2415]

ANTIFRICTION ALLOYS FOR SLIDING BEARINGS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 81 pp 6-9

BUSHE, N. A., doctor of technical sciences, MARKOVA, T. F., engineer, MIRONOV, A. Ye., engineer, and SEVAST'YANOV, V. V., engineer

[Abstract] Antifrictional alloys most widely used for sliding bearings include babbitts and aluminum-tin alloys. Babbitts such as BKA and BK2 are used in railroad cars and diesel engines respectively. A study of these babbitts was made at the All-Union Scientific Research Institute of Railroad Transportation to determine the amount of additives, particularly calcium and sodium, necessary for extending the bearing life by reducing wear and fatigue. This study, involving microstructural analysis and experiments planned according to the method of steepest descent has established that (0.8-0.9)% Ca + (0.6-0.75)% Na in the BKA babbitt and (0.06-0.15)% Ca + + (0.2-0.25)% Na + (0.01-0.04)% Mg + (1.5-2.1)% Sn in the BK2 babbitt are optimum. According to another study, made at the Institute of Physics at the LaSSR Academy of Sciences, partial substitution of lead for tin in aluminum-tin alloys improves friction and wear characteristics at higher temperatures. In the exceptional case of the CO 10-12 alloy (78.03% Al + + 11.2% Sn + 9.9% 0.87% Cu), for instance, the friction coefficient decreases as the temperature rises to about 150°C, then increases again but at a rate that decreases above 180°C. Figures 4, table 1, references 6 Russian.

[171-2415]

PRESSURE TRANSDUCERS FOR MEASUREMENTS ON ROTATING PARTS OF TURBOMACHINES

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 82 pp 41-42

GORELKIN, N. M., candidate of technical sciences

[Abstract] A method of pressure measurement and a special-purpose pressure transducer have been developed by the Planning Department at the Leningrad Metal Works for use in cooling and preheating compartments of turbine runners during operation. The method eliminates the need for a transmitter of pressure signals, inasmuch as electric signals are transmitted from two strain gauges cemented to a circular membrane on one side, the other side of the membrane facing the working fluid. The two transducers, one for each strain gauge responding to flexure of the membrane under pressure, are mounted in a special collector on the runner shaft outside the turbine housing to avoid the effects of high temperature and centrifugal forces. The choice of membrane thickness depends on the pressure range. The electric signals are transmitted from a slip ring, which is coupled to the collector, to a recording potentiometer in the same manner as from a set of

thermocouples for temperature measurements. The transducers are calibrated both statically and dynamically. Figures 4, references 9 Russian.
[177-2415]

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OUTLOOK FOR USE OF MICROTRON IN MANUFACTURE OF POWER MACHINERY

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1, Jan 82 pp 38-40

MELEKHIN, V. N., doctor of physico-mathematical sciences, OVCHAR, V. G., chief engineer at Podol'skiy machine manufacturing plant imeni Ordzonikidze, SHELOBODKIN, V. A., engineer, and GORELOV, N. I., engineer

[Abstract] The microtron is a cyclic electron accelerator consisting essentially of a waveguide, a resonator and an electromagnet. Electrons move in circular orbits of a successively larger diameter in a uniform magnetic field, all orbits originating from their common point of tangency at the resonator exit. In their outermost orbit they reach a tungsten target, which they bombard so as to generate a beam of gamma quanta. The resonator is designed to ensure acceleration in two possible modes with focusing of the electrons after extraction from the emitter and capture into the resonator cavity. The device can thus be used not only for conventional radar, operating with a microwave alternating accelerating electric field, but also for radiation flaw detection on thick objects. Its advantages are an electron beam of high power and small cross section, and controllability of the electron energy as well as of the number of orbits through changes in the resonator position and the electromagnet size (diameter), or through switching from one acceleration mode to another. Theoretical and experimental studies on design and application of microtrons are conducted at the Institute of Physical Problems imeni S. I. Vavilov (USSR Academy of Sciences). There and at the Scientific Research Institute of Internal Flaw Detection a microtron has already been developed with 12 orbits for radiation flaw detection of steam generators at the Podol'sk Machine Manufacturing Plant imeni S. Ordzonikidze. Figures 3, table 1, references 7 Russian.

[177-2415]

MEANS OF INSPECTING GEOMETRICAL PARAMETERS OF INSTRUMENT COMPONENTS

Moscow IZMERENIYA, KONTROL', AVTOMATIZATSIIA in Russian No 5,
Sep-Oct 81 pp 50-60

SARKIN, V. I., candidate of technical sciences, and KRUGLOV, M. G., engineer

[Abstract] Inspection of instrument minicomponents with intricate shapes is reviewed from the standpoint of measurement microprecision that modern technology requires. General-purpose inspection instruments include mechanical and electron-mechanical ones, usually with dial indicators, also optico-mechanical ones such as microscopes and projectors with coordinate grids. Special-purpose inspection instruments include those designed for measuring diameters and shape parameters of holes, diameters of shafts and pins, internal and external taper angles, surface profiles and roughness. A separate category is new optoelectronic inspection instruments that operate with laser beams and diffraction or laser beams and holography, also using television and automatic control with a microcomputer for data processing. Figures 7, tables 5, references 22: 20 Russian, 2 Western.

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